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Social Behaviour in Two Captive Groups of White Rhinoceros (*Ceratotherium simum simum* and *Ceratotherium simum cottoni*)

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With 7 Figures

I. Introduction

The white rhinoceros occurs in two subspecies, *Ceratotherium s. simum* and *Ceratotherium s. cottoni*. The subspecies *C. s. simum* was originally spread south of Zambezi river. The population of that southern white rhinoceros is relatively numerous. There were counted about 3,020 individuals in eight African countries in the year 1980 and the figures of this particular animal have recorded an increase to the total of 3,920 individuals in the year 1984 (Western & Vigne 1985). On the contrary, it is necessary to stress that the northern white rhinoceros *C. s. cottoni*, which had been living in Sudan, Uganda, CAR and Zaire, became nearly extinct. While there had been 400 northern white rhinoceroses in Zaire in 1980, Hillman (1985) stated only 13–15 individuals in 1984. These 13–15 animals in the National Park Garamba (Zaire) represented the last compact group of *Ceratotherium simum cottoni* in the free nature. Van Gysenghem (1984) studied the ecology and behaviour of northern white rhinoceros who had been introduced in the Murchinson Falls National Park (Uganda). Soon after his field research had been finished, all rhinoceroses of that region were exterminated by marauding soldiers.

Many southern white rhinoceroses live in the zoological gardens of the world. The northern white rhinoceros has been only seldom kept in some zoological gardens (17 animals on the whole in the year 1986). The animals are mostly dispersed as individuals, except for the East Bohemian Zoological Garden Dvůr Králové nad Labem (Czechoslovakia), where the only group of 10 animals was kept in the time of the investigation. Three young animals were born in Zoo Dvůr Králové. In spite of such an undisputable success must be stated that the potentionality of the reproduction has not been fully exerted. That is the reason for a research programme, a part of which the ethological research represents.

II. Materials and methods

The ethological investigations were carried out in two groups of white rhinoceros in zoological garden Dvůr Králové. They were concentrated in particular on the animals kept in groups. The behaviour of the animals kept separately is not the topic of this report.

The group of southern white rhinoceros (*C. s. simum*) consisted of five adult individuals, one bull and four cows. The bull was 16, the cows were 12 – 16 years old while the observation was carried out. No calving from any of this group had been reported till then. ♂ "*DAN*" was father of a calf that had been kept separately with its mother.

The enclosure in which these animals were observed had an irregularly oblong shape, maximum length 60 m, maximum breadth 17 m, the whole area was about 960 m².

The group of northern white rhinoceros (*C. s. cottoni*) consisted of six adult individuals, one bull and five cows. ♀ "*NASIMA*" was mother of ♀ "*NASI*" in this group. ♀ "*NADI*" had been showing the symptoms of total chronical disorder in the course of our observation. In the year when the observation was carried out the bull was 10, the cows 9—14 years old, with the exception of ♀ "*NASI*", who was 6.

The enclosure for this group was also of an irregularly oblong shape, maximum length 49.5 m, maximum breadth 23 m, the whole area being 1100 m².

In both enclosures the rhinoceroses had free access to the water. The bulky forage (green grass, hay) was given twice a day in the enclosures. In the evening the rhinoceroses were admitted into their pavilion, where the food concentrates (pellets and others) and hay were prepared for them on the floor of separated boxes.

The investigations were carried out from May till September, i.e. in the warm months, in which it was possible to leave the animals outside in the enclosures all day long. The protocol records from the introductory observations in the year 1981 were not statistically evaluated, they were exploited only as a subsidiary material for the discrimination of various behavioural patterns and their categorization. In the course of the year 1982 the group *C. s. simum* had been observed 220 hours, i.e. 1100 animal/hours, in its enclosure. During the year 1983 the group of *C. s. cottoni* was observed 205 hours, i.e. 1230 animal/hours in its enclosure under the same conditions as the previous group. The data from these two years were summarized for the quantification. The contact with these animals in 1984 - 1985 was not interrupted, but the work on rhinoceroses was directed in a different way.

The first steps of the three-year research were devoted to the distinction of different behavioural patterns and to their categorization. In the category of social behaviour the behavioural elements were described as the entirety of particular movements. At the same time it was necessary to record the reaction of other animals, i.e. to find the consequences of the observed movements. The interpretation of each social element was based on the records of the reaction of other animals if such an element occured.

The protocol records from the two-year observation were summarized in the matrices. The evaluation of these data about both scanted groups started with basic comparison in tables and graphs. The significance of differences in the both dyadic agonistic and affiliative relations was evaluated according to the Fisher's test (Anděl, 1985), which is analogous to the chi-square test.

The index of aggressivity in accordance with Collias (1975) and Sachser (1983) was also used for evaluation of the agonistic behaviour. In the affiliative (cohesive) behaviour the "attractiveness" of partners was evaluated in a way which is analogous to the index of aggressivity.

The results gained according to following formulae

$$\frac{Ag^{r}}{Ag^{r} + Ag} \quad \text{and} \quad \frac{KOH^{r}}{KOH^{r} + KOH^{s}},$$

where Ag^{r} is the sum of all aggressive activities towards other animals
Ag^{s} is the sum of all aggressive activities of group members adressed to the animal
KOH^{r} is the sum of all affiliative activities addressed to the animal
KOH^{s} is the sum of all affiliative activities recorded in behaviour of the animal

will be submitted to criticism in the discussion.

III. Results

A. Agonistic behaviour

The activities of the agonistic behaviour recorded under described conditions of captivity in the zoological garden belonged in particular to the threats or defensive threats (i – iii):

(i) attacking by means of clashing horns: one animal with lowered head attacked the other and clashed horns with it. In some cases the attack was accompanied by some acoustic displays (snorts, growling). Some partial (intention) forms of that attack were recorded, too: turning head and body towards the disturbing animal; lowering the head and exercising a few steps forward towards the other animal; the acoustic displays during these movements. Even these partial forms can frequently stop the approach of the other animal. Owen-Smith (1975) interpreted the horn clash threat as a "symbolic" attack.

Fig. 1. Snarl display: the cow with mouth opened lets out a loud roar.

(ii) threating by means of swinging the head and jumping up with its forefeet: the animal stood on all four feet, leaned down and turned its head aside and swung suddenly the head drawing with it a big bow from side to side. In some cases even the adult animal jumped up a little only with its forefeet and performed swinging the head. This activity was observed even in a calf aged 15 days which used the threat towards the disturbing people. In adult animals the performance of that activity was recorded both towards unknown people and other rhinoceroses.

(iii) snarl display (as described by Owen-Smith 1975): the head was thrust forwards, ears laid back, and mouth opened to let out a loud rasping roar; sometimes the snarl was coupled with a few advancing steps, and occasionally an advancing snarl ended in a clash of horns or a horn prodding gesture. The "throwing out the head" was many times observed as an intention form of that activity: the animal with the head taken up almost horizontally with its neck craned markedly forward and with ears laid back reacted to an approaching partner.

There were recorded also other elements of agonistic behaviour (iv – v):

(iv) pressing: the animal pressed against another rhinoceros with its bodyside or with its neck and forehead in such situations when the animal competed with another/others for the place of rest (shadow of shelter in hot days), for forage or for exclusive contact with the partner.

(vi) attacking another animal with horn to body blows.

Table 1. Agonistic behaviour

		1. clashing horns	1a. partial forms of 1.	2. swinging head	3. snarl display	3a. partial forms of 3.	4. pressing	5. horn to body blow	Total
group of ♂ ♂ absent	♀ "NAŠA"	38	71	—	15	4	6	12	144
	♀ "ZAMBA"	31	62	1	8	1	16	11	133
	♀ "FAIT"	106	136	17	41	10	17	24	351
	♀ "ŠMITKA"	50	60	1	31	13	8	10	168
	♂ "DAN"	6	13	—	—	2	4	3	28
group of ♂ ♂ present	♀ "NAHIMA"	26	210	—	113	11	1	115	491
	♀ "NEHARI"	9	14	—	2	—	3	32	60
	♀ "NASI"	32	61	—	3	1	19	53	112
	♀ "NOLA"	16	13	—	—	—	13	26	68
	♀ "NADI"	19	16	—	1	11	5	13	65
	♂ "SUDAN"	42	82	—	—	—	3	83	190
	Total	379	714	19	214	53	93	385	1820
	%	18.8	39.2	1.0	11.8	2.9	5.1	21.2	100

The frequency of particular elements of agonistic behaviour is shown in Table 1. The most frequent activity was clashing horns and its partial forms (58% of all aggressive activities). Another way of direct attack – horn to body blow – was often observed, too (21% of all aggressive activities), but in none of the both groups aggressive activities resulting in a heavy injury of animals was observed in the course of the observations. It was possible to observe only some bleeding scratches on the skin of head around the horns even after the heaviest conflicts. The swinging head was observed quite often with ♀ "*FAIT*", whereas it was hardly ever observed in other animals in social conflicts. However it occured in other animals as a reaction to the disturbing people, which, of course, could not be given in the Table 1 that includes interindividual behaviour only.

All animals in our investigations reacted to an attack, threat of their intentions with stopping, retreating or running away. The attacked animal offered many times resistance by such interactions as clashing horns or pressing, but the conflicts could not be evaluated as "won" or "lost" because under our conditions in the end it was the attacked animal that had retreated. Therefore it was necessary to use other methods of evaluation that the simple classification according to the "score" of won conflicts.

The result matrix of agonistic behaviour of the group *C. s. simum* is given in the Table 2 and in Table 3 for the group *C. s. cottoni*. In these matrices activities (i) – (v), were used as basis for following statistical treatment, but not that part of agonistic behaviour that can be characterized as stopping or retreating of the attacked animal following immediately or after a short period after the attack.

Table 2. *Ceratotherium s. simum* – agonistic behaviour

Agonistic activities directed to the animal	Agonistic behaviour towards other animals					
	"SAŠA"	*"ZAMBA"*	*"FAIT"*	*"ŠMUDLA"*	*"DAN"*	Total
"SAŠA"		1	73	7	14	95
"ZAMBA"	1		46	9	4	60
"FAIT"	76	84		30	7	197
"ŠMUDLA"	16	26	113		3	158
"DAN"	51	22	118	122		314
Total	144	133	350	168	28	

From total recordings of agonistic behaviour manifestations results that the frequency of such behaviour in both groups is almost the same: 0.77 of the element in an animal/hour in the group *C. s. simum* and 0.81 of the element in an animal/hour in the group *C. s. cottoni*.

Further, by simple numerical comparing it can be found out that ♀ *"FAIT"* is the most active animal in this respect in *C. s. simum*, and ♂ *"DAN"* is the animal towards which the most agonistic activities had been aimed at. Analogous with the group *C. s. cottoni*, ♀ *"NASIMA"* is the most active animal of the group and bull again, ♂ *"SUDAN"*, as the animal towards which most agonistic activities had been aimed at.

Table 3. *Ceratotherium s. cottoni* — agonistic behaviour

Agonistic activities directed to the animal	Agonistic behaviour towards other animals						
	"NASIMA"	"NESARI"	"NASI"	"NOLA"	"NAIT"	"SUDAN"	Total
"NASIMA"		13	21	28	12	17	91
"NESARI"	32		6	5	4	29	76
"NASI"	79	4		7	6	41	137
"NOLA"	25	5	9		2	18	59
"NAIT"	60	5	18	9		75	167
"SUDAN"	286	33	88	19	41		466
Total	481	60	142	68	65	180	

In dyadic relations numerous differences in quantity of attacks, threats and further elements of agonistic behaviour, through which the animal inhibits the partner's behaviour, can be found, consequently it can be assumed by the more numerical comparing, that the animal with higher quantity of such elements is the dominant animal.

In this way of evaluation a certain "hierarchic" rank order in the group can be arranged. This group "organization" derived from agonistic behaviour evaluation could be expressed in a graphic way, a comparative simple ladder in *C. s. simum* group, a more complicated structure with a few feedback loops in the *C. s. cottoni* group.

In evaluating the significance of agonistic behaviour differences in dyadic relations by Fisher's test (Tab. 4 and 5) can be seen that not in all relations significant dominance of one animal over the other one can be found. On the other hand, however, 8 significant dominance relations out of 10 possible in the groups *C. s. simum* and also 8 signifi-

Table 4. *Ceratotherium s. simum* — estimation of differences in agonistic behaviour in dyadic relations

"SASA"	→ "ZAMBA"	p = 0.8881	NS
	→ "FAIT"	p = 0.7282	NS
	→ "ŠMUDLA"	p = 0.0057	S
	→ "DAN"	p = 0.0000	S
"ZAMBA"	→ "FAIT"	p = 0.0040	S
	→ "ŠMUDLA"	p = 0.0001	S
	→ "DAN"	p = 0.0000	S
"FAIT"	→ "ŠMUDLA"	p = 0.0030	S
	→ "DAN"	p = 0.0000	S
"ŠMUDLA"	→ "DAN"	p = 0.0000	S

S = significant; NS = non-significant

Table 5. *Ceratotherium s. cottoni* – estimation of differences in agonistic behaviour in dyadic relations

"NASIMA"	→ *"NKSARI"*	p = 0,001	S
	→ *"NAST"*	p = 0,0000	S
	← *"NOLA"*	p = 0,3437	NS
	→ *"NADI"*	p = 0,0000	S
	→ *"SUDAN"*	p = 0,0000	S
"NKSARI"	↔ *"NASI"*	p = 0,3283	NS
	↔ *"NOLA"*	p = 0,6721	NS
	→ *"NADI"*	p = 0,5002	NS
	→ *"SUDAN"*	p = 0,2901	NS
"NASI"	→ *"NOLA"*	p = 0,0821	NS
	→ *"NADI"*	p = 0,0000	S
	→ *"SUDAN"*	p = 0,0000	S
"NOLA"	→ *"NADI"*	p = 0,0045	S
	→ *"SUDAN"*	p = 0,1998	NS
"NADI"	← *"SUDAN"*	p = 0,0000	S

S = significant; NS = non-significant

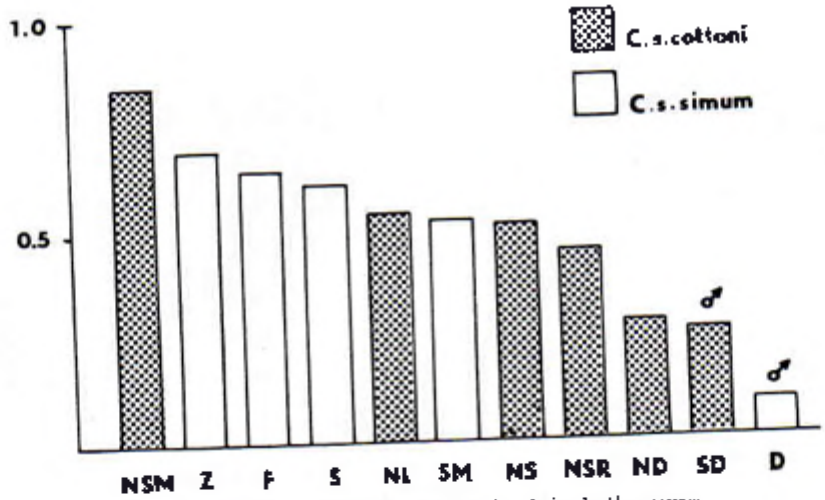

Fig. 2. Aggressivity index in all observed animals of the both groups

cant dominating relations out of 15 possible dyadic relations in the group *C. s. cottoni* can be found. This could be assumed that in both groups there is dominance of some cows over other cows and over the bull. The highest number of submissive positions can be found in bulls in both groups, moreover the sick cow *"NADI"* in the group *C. s. cottoni* belongs to them too.

Aggressivity index should evaluate participating of the animal in the conflicts in the group and thus give the additional information about the position of the animal in its group. Fig. 2 includes all the observed animals of the both groups. The highest index is given in ♀ "*NASIMA*", the both bulls being situated at the end of the sequence.

B. Affiliative behaviour

The affiliative (cohesive) behaviour takes a marked part of the white rhino's behaviour in captivity. The following activities were recorded:

(i) contacts with a partner by head:

- rubbing its head against another animal
- raising the head of another animal with its forehead
- touching and/or rubbing its horn against another animal
- putting its horn on another animal's body
- touching and/or rubbing its lips against another animal's body
- lying with its head on a flank of another lying animal
- placing its head from behind between the hind legs of another standing or slowly moving animal
- placing its head and neck on another animal

Fig. 3. Putting horn on another animal's body

Fig. 4. Placing head on the another animal's trunk from the side

Fig. 5. The standing animal performs pressing its hind part to the lying animal's trunk

(ii) contacts with a partner by body
- pressing its hind part to another animal

The following actions were also recorded (iii – v):

(iii) approaching to another animal

(iv) following

(v) lying, standing and walking side by side

Rhinoceroses made frequently body contact with one another by head or horn. Many activities are very similar, however it is possible to distinguish them as single elements. For instance, the touching and/or rubbing-its-horn against another animal is undoubtedly very similar to the putting-its-horn on another animal's body. However when putting the horn against another animal (Fig. 3) the active animal places itself upright to the longitudinal axis of its partner (T-posture), it leans its horn against its side, the eyes half closed. By touching and/or rubbing horn the animal wipes its horn tenderly against various parts of the partner's trunk, legs and head without taking any pronounced position in respect to the partner's body position.

The touching-and/or-rubbing lips against another animal's body can change into "biting off" the partner's skin, the animal salivates amply and leaves wet traces on the partner's skin. Touching, rubbing and "biting off" is directed towards the partner's trunk and legs. The touching with closed lips another animal's flank by adult animals is very similar to the motions of the calves to their mother's udder and perhaps should be categorized separately.

The lying-with-head-on-flank of another lying animal was frequently observed in the calf that was kept with its mother in a separate enclosure. The occurrence of the mentioned element in adult cows can be derived from such an infantile behaviour.

The placing-head-and-neck on another animal was performed from the side or from the back towards the lying or standing animal. It can follow after other activities or be elicited by another animal by pushing its hind part under the partner's head when retreating. After putting the head, wiping the chin and the throat against the partner's back sometimes an attempt to mount the partner's trunk with the front legs appears. After such an attempt in the interaction between the cows, the lower animal forwards a few steps forward and prevents so mounting of the other animal on its back. In some situations even an aggressive manifestation (protest) followed after placing the head on the animal's back: snarling against the female, roaring against the male.

From the contacts with the partner by body, only pressing-hind-part (Fig. 5) could be observed, when lying or standing animal leaned its hindquarters against the trunk or hindquarters of the other lying or standing animal (T- or L-posture). It is possible to derive it from the infantile behaviour, it being otherwise a quite common element in a several days old calf that after having been disturbed by a man retreats for fear towards its mother leaning against her by its hind part. Tactile contacts by rubbing its side against that of the other in passing as described by OWEN-SMITH (1975) were not recorded. Such an activity is obviously distinctly distinguishable in nature conditions, whereas in the milieu of enclosures and stables cannot be distinguished from other body contacts due to rather little room. Neither common lying could be quantified that occured previously in the group *C. s. cottoni*. The animals were lying on the sand in their enclosure (i.e. on the soft ground) and in windy weather on the leeward or in the stable in groups, pressed in various ways against each other, without

respecting individual distances. Such a group lying differs substantially from the lying side by side of the two animals when the animals lay with their heads and trunk axis in one direction, with the distance ranging 0—1 m apart from each other.

There are two result matrices for affiliative behaviour set up from the basic tables for each group of animals. The first matrix includes only affiliative contacts by head and body as well as active maintaining of contacts with the partner (i—iv); in the second one there are also both lying and standing and walking side by side (i—v) included. The basic tables and all the four matrices that served as the basis for the statistical evaluation are given in another report (Miketić (1980). The frequency of elements of affiliative behaviour is shown in Table 6. From total recordings of affiliative behaviour follows that the total frequency of such behaviour in both groups is quite different. 0.74 of the element in an animal/hour in the group *C. s. simum* and 0.18 of the element in an animal/hour in the group *C. s. cottoni*. Further the high occurance of lying, standing and walking side by side shown in the females, "*SAŠA*" and "*ZAMBA*" is quite striking. Therefore the next step was made in verifying if the animals prefer some of their partners and stay with them longer than with the others. From the Fig. 6 can be unambiguously seen that there was mutual preference between "*SAŠA*" and "*ZAMBA*" in the group *C. s. simum* as the partners for lying, standing and walking side by side together. The number of such acts in other animals is irrelevant to that in "*SAŠA*" and "*ZAMBA*".

Table 6. Affiliative behaviour

		contacts by head	contacts by body	approaching	following	lying, standing, walking side by side	Total
group of *C. s. cottoni*	♀ "*SAŠA*"	34	2	24	20	178	258
	♀ "*ZAMBA*"	60	3	29	14	176	282
	♀ "*FAIT*"	43	8	47	35	9	142
	♀ "*SMUDLA*"	17	—	11	18	8	60
	♂ "*DJIN*"	10	—	46	5	9	70
group of *C. s. simum*	♀ "*NASIMA*"	12	—	1	3	7	23
	♀ "*NESARI*"	10	1	5	2	18	36
	♀ "*NASI*"	20	1	9	8	9	51
	♀ "*NOLA*"	8	—	3	—	10	21
	♀ "*NADI*"	8	—	8	5	16	37
	♂ "*SUDAN*"	9	—	25	14	1	52
	Total	231	18	211	125	444	1032
	%	22.1	1.7	20.7	12.1	43.0	100

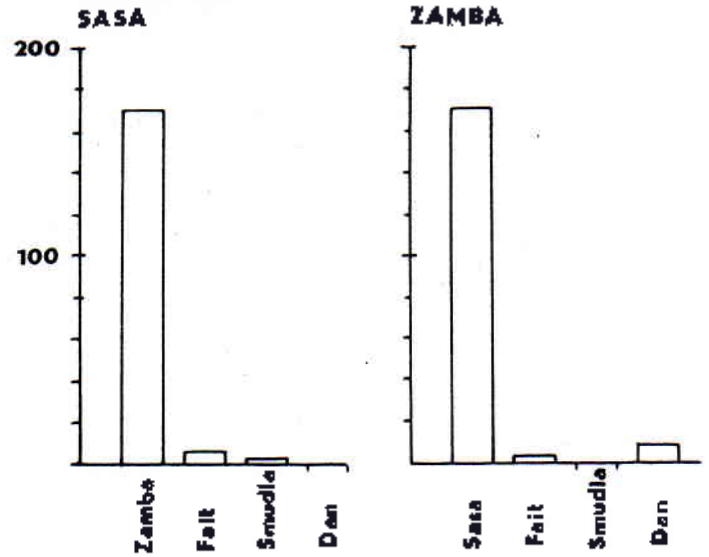

Fig. 6. Mutual preference of "*SAŇA*" and "*ZAMBA*" in the group *C. s. simum*

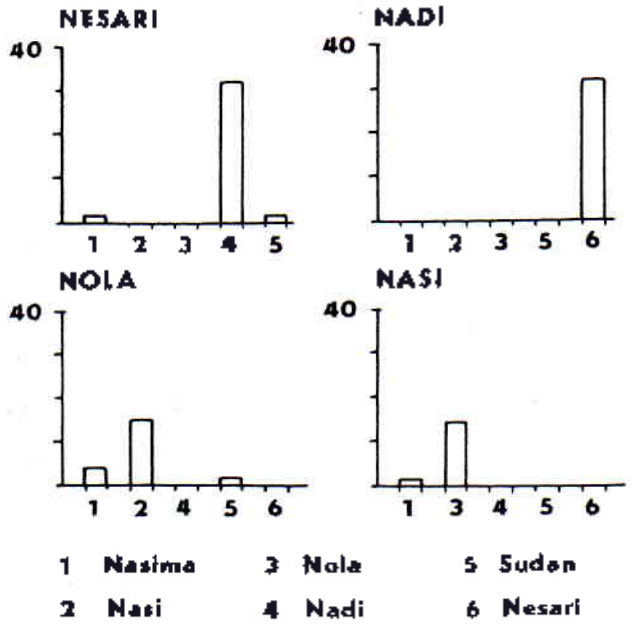

Fig. 7. Mutual preference of two couples in the group *C. s. cottoni*

Also in the group *C. s. cottoni* a certain mutual preference in the dyads "*NESARI*" – "*NADI*" and "*NASI*" – "*NOLA*" occured (Fig. 7).

When evaluating the mutual providing affiliative activities it can be seen that in the group *C. s. simum* the female "*FAIT*" is the most active animal while the female "*SMUDLA*" shows the lowest frequency. By setting up a ladder of the addresses of

the affiliative activities, the sequence, "*ŠAŠA*" – "*ZAMBA*" – "*FAIT*" – "*ŠMUDLA*" – "*DAN*" can be seen with the only feedback loop when "*ŠMUDLA*" seems to be more attractive for "*ŠAŠA*". As it can be seen from the Table 7, the differences in the attractivity of the single animals is significant. The attractivity ladder naturally differs from the index rank of the animals in the group (Table 8) which is "*ŠAŠA*" – "*ZAMBA*" – "*ŠMUDLA*" – "*FAIT*" – "*DAN*".

Table 7. *Ceratotherium s. simum* – significance of differences in affiliative behaviour in dyadic relations

		all affiliative activities and actions [i – iv]		[i – iv]	
"*ŠAŠA*"	← "*ZAMBA*"	p = 0.152	S	p = 0.0000	S
	← "*FAIT*"	p = 0.0000	S	p = 0.0000	S
	← "*ŠMUDLA*"	p = 0.0097	S	p = 0.0059	S
	← "*DAN*"	p = 0.0017	S	p = 0.0017	S
"*ZAMBA*"	← "*FAIT*"	p = 0.0000	S	p = 0.0000	S
	← "*ŠMUDLA*"	p = 0.0000	S	p = 0.0000	S
	← "*DAN*"	p = 0.166	S	p = 0.0019	S
"*FAIT*"	← "*ŠMUDLA*"	p = 0.0004	S	p = 0.0000	S
	← "*DAN*"	p = 0.0001	S	p = 0.0000	S
"*ŠMUDLA*"	← "*DAN*"	p = 0.0001	S	p = 0.0000	S

S – significant. The arrow indicates the more attractive partner.

Table 8. Attractivity values index

Ceratotherium s. simum		*Ceratotherium s. cottoni*	
"*ŠAŠA*"	0.682	"*NASIMA*"	0.723
"*ZAMBA*"	0.621	"*NOLA*"	0.507
"*ŠMUDLA*"	0.461	"*NESARI*"	0.500
"*FAIT*"	0.359	"*NADI*"	0.442
"*DAN*"	0.244	"*SUDAN*"	0.300
		"*NASI*"	0.365

In the group *C. s. cottoni* the most active animal in providing affiliative activities proved to be the bull "*SUDAN*", the lowest frequency showed the cow "*NOLA*". By numerical evaluation of the addressees of affiliative activities the female "*NASIMA*" with 53 recorded activities and acts directed towards her is leading, followed by the bull "*SUDAN*" with 26 recordings and then by a cluster of the animals "*NOLA*" (19), "*NADI*" (18), "*NESARI*" (18) and "*NASI*" (18). We did not manage to prove a direct connection (coherence) between providing and accepting affiliative behaviour activities in any group.

Only five or four relations out of 10 dyadic relations in the group *C. s. cottoni* showed by selected $p = 0.05$ that one animal is significantly more attractive for its partner. It is obvious that in this case any trying to arrange a single animal attractivity into a ladder will be of no use. More pronounced position has only the cow "*NASIMA*" with three relations, where she proves to be a significantly more attractive animal for her partners.

When evaluating affiliative behaviour by means of the attractivity index (Table) the female "*NASIMA*" stands on the top of the whole sequence. In this connection must be mentioned that "*NASIMA*" is the only female that bears the calves. Attractivity index of "*NASIMA*" is the highest of all the observed animals in both groups. The bull "*SUDAN*" is suppressed to the last but one place. The lowest place in this evaluation took "*NASI*" who was six years old, i.e. on the edge between a subadult and adult animal in the period of observance.

Table 9. Ceratotherium s. cottoni – significance of differences in affiliative behaviour in dyadic relations

		all affiliative activities and actions [i – v]		[i – iv]	
"*NASIMA*"	→ "*NESARI*"	p = 0.4000	S	p = 0.0143	S
	← "*NASI*"	p = 0.2779	NS	p = 0.2586	NS
	↔ "*NOLA*"	p = 0.5002	NS	p = 0.5000	NS
	← "*NADI*"	p = 0.0143	S	p = 0.0143	S
	← "*SUDAN*"	p = 0.0000	S	p = 0.0000	S
"*NESARI*"	← "*NASI*"	p = 0.5000	NS	p = 0.5000	NS
	→ "*NOLA*"	p = 0.2083	NS	p = 0.2085	NS
	→ "*NADI*"	p = 0.0400	NS	p = 0.2331	NS
	← "*SUDAN*"	p = 0.5002	NS	p = 0.5000	NS
"*NASI*"	→ "*NOLA*"	p = 0.0904	NS	p = 0.0285	S
	→ "*NADI*"	p = 0.2428	NS	p = 0.2428	NS
	→ "*SUDAN*"	p = 0.0036	S	p = 0.0035	S
"*NOLA*"	← "*NADI*"	p = 0.2885	NS	p = 0.2885	NS
	↔ "*SUDAN*"	p = 0.5001	NS	p = 0.5003	NS
"*NADI*"	→ "*SUDAN*"	p = 0.1975	NS	p = 0.1975	NS

S = significant; NS = non-significant; The arrow indicates the more attractive partner.

IV. Discussion and conclusions

A. Agonistic behaviour

Variability of the observed agonistic behaviour in the zoological garden does not include a scale of activities and actions during the encounter of two alpha-males. It is due to the fact that according to the accepted measures in arranging the breeding groups there was always only one male in a group of animals.

The most frequently observed activity of the agonistic behaviour, clashing horns, is in fact harmless not only when it is performed mildly, but even if loud strokes can be heard. Threating by means of swinging the head has not been described yet in the white rhinoceros in nature. Although no recording about its occurence in the group *C. s. cottoni* has been found during evaluation of the protocols, it was observed in this group beyond the period evaluated. It was observed in the isolated animals as well. A fast approaching of an unknown human to the animal in the box (where the visitors had no access) recalled it regularly if the animal got frightened. A similar kind of swinging the head several times to the sides in black rhinoceros was described e.g. by Vágner (1979), who depicts an attack on its car in the bush: the animal ran up to the car, then suddenly braked, swang its head and snorted several times.

A marked activity of the agonistic behaviour was the snarl display (this term was used by Owen-Smith 1975) when the animal opened its jaws to give out a loud roar. A weaker adult animal used to do so against a stronger individual, in our case it was a cow against a bull. The roar was really loud and strong. Laurie (1982) described similar behaviour in the Greater Indian one-horned rhinoceros. The existence of lower incisor tusks in the Greater Indian rhinoceros makes clear the genesis of this behavioural element, because displaying of teeth by opening the jaws is a common threat posture by many animal species. The white rhinoceros has not any incisor tusks in its mandibula. For that reason the precise arguments for making clear the genesis of that white rhino's behaviour can only be given by paleozoology.

The summaries of agonistic behaviour that have been done demonstrate that the animals form dyadic relations in which one animal can highly assert itself. It means that the numbers of aggressive and similar activities of the animal A against the animal B are distinctly higher than those of the animal B against the animal A. Even by using strict measures ($p \leqq 0.05$) most relations with significant superiority of one animal over the other can be found. In many other species of animals besides rhinoceros this asymmetry in social relations could be called a social dominance, without hesitation. In the white rhinoceros the only social dominance relation observed in the free nature was described by Owen-Smith (1975) only between alpha- and beta-bulls. Alpha-bull becomes prevalent on its territory and 0–3 beta-bulls can live on the same territory simultaneously. The beta-bulls, unlike the alpha-bull, do not participate in reproduction. There are many differences in behaviour of alpha- and beta-bulls even when they encounter one another. The cows need not respect the territories of the bulls. They have their own home ranges which may take up more territories of alfa-bulls. The home ranges of cows overlap each other considerably, but the social relations of the females in nature are based on a certain dividing of the area. There is no report on ethology of white rhinoceros (Backhaus 1964, Owen-Smith 1975, van Gyseghem 1984) that would give evidence about permanent superiority of one female over the other in the nature. However under captivity conditions the differences showing the superiority of one female over the other and even over a male do occur. Does it really represent a social dominance?

Due to the fact that the social dominance resulting from agonistic behaviour is considered the most important part of social behaviour by many ethologists, great attention was given to defining of social dominance. Rowell (1974) taking an empirical attitude concludes that the term "dominance" may be useful in the same way as a shorthand term in showing that the result of any agonistic or competitive interaction between two animals can be predicted on a practical certainty level. Deag (1977) says

that the dominance refers to the animal who performs more threats in a given dyade than its partner and who is more avoided by his partner than it avoids its dyadic partner. Dewsbury (1982) indicates that the fundamental element in and basis for the definition of dominance is a stable asymmetry in the agonistic behaviour of two or more animals. A simple attitude towards social dominance maintain e.g. Bernhardt & Zeeb (1982) who take for proved that the dominance is present whenever the behaviour of one animal is inhibited in another animal's presence.

However nearly all given authors (Rowell 1966, 1974, Drag 1977, Dewsbury 1982) indicate that subordinated animals can play greater part than dominant animals in determination of the relation "dominance – submissivity". Rowell (1974) when reflecting about hierarchy takes the term "submissivity hierarchy" for much more descriptive than "dominance hierarchy". Drag (1977) defines as subordinated in relations between two partners the animal whose behaviour is limited by another animal and who – last but not least – displays submissivity.

If we take in account only more simple view on social dominance that results from evaluating the superiority of one animal over the other, we have managed to prove existence of numerous social dominance relations in both of our groups. However if we take in account behaviour of the "subordinated" animal, too, there is still a question left if it really is possible to evaluate "submission" only from the fact that the animal who had been attacked always retreated in the end. I assume that if we speak about dominance of a female over other females or even over a male in this particular case in two groups of white rhinoceros being observed, this expression on descriptive level could be used as an empirically verified term only. It must be stressed that the "dominance" is only an artifact caused by an unnatural accumulating of the animals on a limited area and it is not a true social dominance.

The attempts to evaluate mutual aggressivity of the animals by means of some of the index methods have deep roots in ethology (see e.g. Schein & Fourmann 1955). Index calculations can be very simple or – on the contrary – elegant mathematic formulae can be used. The dominance indexes in calculation of which not only aggressive activities of the animals are calculated, but where elements of submissive behaviour are also included into evaluation are interesting and obviously also more objective. Such evaluation by means of dominance indexes can be found e.g. in Zumpe & Michael (1986) and can give a true picture of rank order (ordinal rank) and also determine the degree or extent to which the higher-ranking animal dominates over the next lower-ranking animal (cardinal rank) and in the same time correspond with fight interaction matrices. However since in both groups of white rhinoceros there are justifiable doubts about possibility of evaluating the regular retreat of the animal being attacked as a submissive behaviour, this or similar procedure cannot be used for evaluating of their social relations. Therefore the most simple possible formula for reaching aggressivity index was purposely used.

The results given in Fig. 2 show following:

– The both bulls in the two groups had the lowest index, their "rank" was the lowest of all animals. Both males in both groups are the most frequent object of aggressive activities. Hence the social stress of both males incorporated into groups is high. In this connection let us mention that the behaviour of a beta-male in free nature, whose behaviour is inhibited by the presence of the alpha-male in the area, suppresses the reproduction abilities in such an extent that Leuthold (1977) marked the

beta males as social castrates. There is an open question left: to what extent such very frequent aggressive activities of females towards the male form a social stress that supresses reproduction abilities of the males. I suppose that the unnatural position of the males in the group of animals on a limited area of enclosures will have a negative influence on abilities and willingness of the males to mate.

— The third animal from the end of the ladder with a low index, a cow, was ill at the time of the investigation. Its position was comparable with the positions of the bulls.
— The only cow which produced calves headed by all means all the animals taken in this account.
— The cows without reproduction activity (all the others) form a cluster without any significant differences in this account.

It is necessary to exercise a certain reserve in the interpretation of this figure, nevertheless it is evident that the behaviour and the position of the cow with reproduction activity, the behaviour and the position of the cows without reproduction activity and the behaviour and the position of bulls were different. Further reason for such a cautious attitude to the used aggressivity index is the fact that the rank of animals gained by means of this index is not in compliance with the dates of the Tables 4 and 5, i.e. with the evaluation by means of the differences in agonistic behaviour in dyadic relations. Anyway it provides some helpful dates for evaluation of social stress in the animals.

8. Affiliative behaviour

The behaviour that is described as affiliative in this report was also recorded by Owen-Smith (1975) in white rhinoceros in free nature. He describes following activities and acts: grazing side by side for several minutes; moving of two animals side by side, rubbing the head against other animal's body; rubbing its side against that of the other in passing; lying together when a close companion lay down almost touching; panting sound as the expression of the effort to come nearer; moving towards another individual for restoring close spacing. When comparing with this inventary of affiliative behaviour, the inventary of affiliative behaviour reported in the captive rhinoceroses seems to be much richer. Without changing anything in this evalnation a supposed objection can be accepted, that various ways of touching the head and horn could be by another observer included into one gesture group. On the other hand, however, the touching and/or rubbing lips against another animal's body passing even into "biting" the partner's skin with lips, has undoubtedly much common with mutual cleaning and biting out the hair, that Hassenberg (1971) reports in all perissodactyls from the family Equidae. This gesture in the *Equidae* is mostly superficial, but it is often a thorough procedure being made on all places of the body where the animal cannot reach with its own teeth in Grant zebras and all horses when they are changing the hair from the winter hair to the summer hair. As the white rhinoceros has nearly bare skin, such biting has lost its original biological function and has been used in social behaviour only.

If the frequency of the recorded affiliated behaviour in rhinoceros is higher than it is common in animals living in free nature, cannot be determined. Owen-Smith (1975) had been observing a dyade cow-cow for 19 hours, i.e. 36 animal/hours and found out 1 tactile contacts, which represents 0.11 of the element per 1 animal/hour. In the group *C. s. simum* 0,16 tactile contacts per 1 animal/hour were ascertained. However, it can-

not be determined, if we have found an increase or decrease of affiliative behaviour frequence in the animals kept in captivity, because our compering was done with only one dyade cow-cow. Rowell (1967) compared behaviour of a wild and a caged baboon group and found out, that in the caged group there were some changes in affiliative (friendly) behaviour much more pronounced than the changes in "approach-retreat behaviour" into which the author included aggressive behaviour too. In the group of caged baboons all forms of tactile contacts with friendly meaning were much more frequent. The only exception was grooming that was – just on the contrary – more frequent in free living animals. An analogous conclusion in rhinoceros could not be drawn.

A very striking feature in the group *C. s. simum* was a long-term bond between the cows *SASA* & *ZAMBA*. In the group *C. s. cottoni* a certain tendency towards mutual preference occured too. The occurence of interindividual associative bonds between adult animals has been described in the horses (Tyler 1972, Arnold & Grassia 1982), domestic cattle and African cattle zebu (Sambraus 1976, Reinhardt & Reinhardt 1981). These associations can occur both between relative and non-relative herd members. Certain family bonds between black rhinoceros described Schenkel & Schenkel-Hulliger (1969). They were based on the relations between mother and adult descendants. However three cases of two bulls who made a "social group" moving and grazing together were observed too. The association of males reminds rather of a social organization of such animal species where males form bachelor groups.

Stratification of the affiliative acitivites in the group is a kind of evidence about the relations in this group. Rowell & Olson (1983) concentrated their study of the behaviour in monkeys *Erythrocebus patas* on the analysis of mutual approaching of the animals: who is approaching to whom and who is approached. This simple measurement showed the relations between individuals and could be used to describe the social organization of the group. The other sources of the information only duplicated the basic description. However, the analysis of the affiliative behaviour of the rhinoceros do not allow to make unambiguous conclusions. Ranking the animals according to the index "being approached"; "approaching" (attractivity index) indicates only a certain sexual dimorphism in behaviour that is expressed in the group of southern rhinoceros more expressively than in the northern rhinoceros group. The analysis of the affiliative behaviour has brought important information, however, it is not deciding for the interpretation of the basic social relations in the groups. This fact is based particularly on the result of the evaluating: in spite of using several ways of evaluating the affiliative behaviour in the group of southern rhinoceros, we only succeeded in proving that the females "*SASA*" and "*ZAMBA*" take stabile leading position in the group, and the male "*DAN*" is in the end of the rank. As the most substancial conclusion for the evaluation of the group of northern rhinoceros can be accepted the fact that "*NASIMA*, the only female that bears the calves, is the most attractive partner for all group members.

C. Social behaviour as a whole

Social behaviour of the both rhinoceros groups was very strongly marked by accumulating of the animals on a limited area of the enclosure. Hall (1965), Hall et al. (1965), Rowell (1967), Gartlan (1968). Alexander & Roth (1971) devoted their

attention to the differences between the animals behaviour in large enclosures and little cages. The given works correspond in the fact that in captivity or in smaller rooms the mutual aggressivity is increasing.

It is reported even quantitative growth of affiliative (friendly) behaviour (Rowell, 1967). Therefore the hierarchy structure of groups is very pronounced. The observation in the both rhinoceros groups gave similar results. Aggressive clashes between animals resulted in forming an artificial dominance of some animals over other individuals so much that they formed appearance of a certain "hierarchy". Such a hierarchy can be also expected according to some results in evaluating of affiliative behaviour.

However the sharping of the social relations in the rhinoceros group is hardly ever striking for a common observer. In a five-member-group *C. s. simum* total 824 antagonistic activities during 220 hours was observed, i.e. about 3.75 agonistic activites in an hour, which represents about 0.75 activity per one animal/hour. In this connection it may be mentioned that e.g. Clutton-Brock et al. (1976) who concentrated themselves on the aggressive activity in the feral horses reported 1.88 agonistic activities per one animal/hour. When compared with feral horses, the rhinoceros groups shows two and a half times fewer agonistic activities. The given numbers show that from the point of view of a short-term observer and even from the point of view of a common activity in a zoological garden there is hardly anything special going on in the rhinoceros enclosures. However, the reproduction rate of such animals is — but for one exception — zero.

The captive animals are under influence of numerous stressors. For the rhinoceros living in the described conditions it represents mostly a constant visual contact with the partners and necessity to react to their behaviour, reduced distance between individuals and no possibility to leave the area governed by a stronger individual. A lot of pages have been filled with description of the influence of a social stress on the animal's organism. However, there is no doubt that a certain level of stress belongs to the life and the wild animals are already phylogenetically adapted to a particular stress level. An important part in effect of stress also plays the animal's individuality, the habits and ability of the animals to adapt themselves. The basic criterion for the "bearable" rate of the stress can only be the reproduction of the animals. Judging after the rate of reproduction of these animals, it is necessary to evalmate the influence of social stress, too. This was also the reason for carrying out some changes and transfers in the zoological garden in Dvůr Králové.

Summary

The social behaviour in a group of southern white rhinoceros (*Ceratotherium s. simum*) and in a group of notaern white rhinoceros (*Ceratotherium s. cottoni*) was investigated in their enclosures in a zoological garden. The possible influence of limited areas in captivity on behaviour and reproduction in white rhinoceros was discussed.

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